

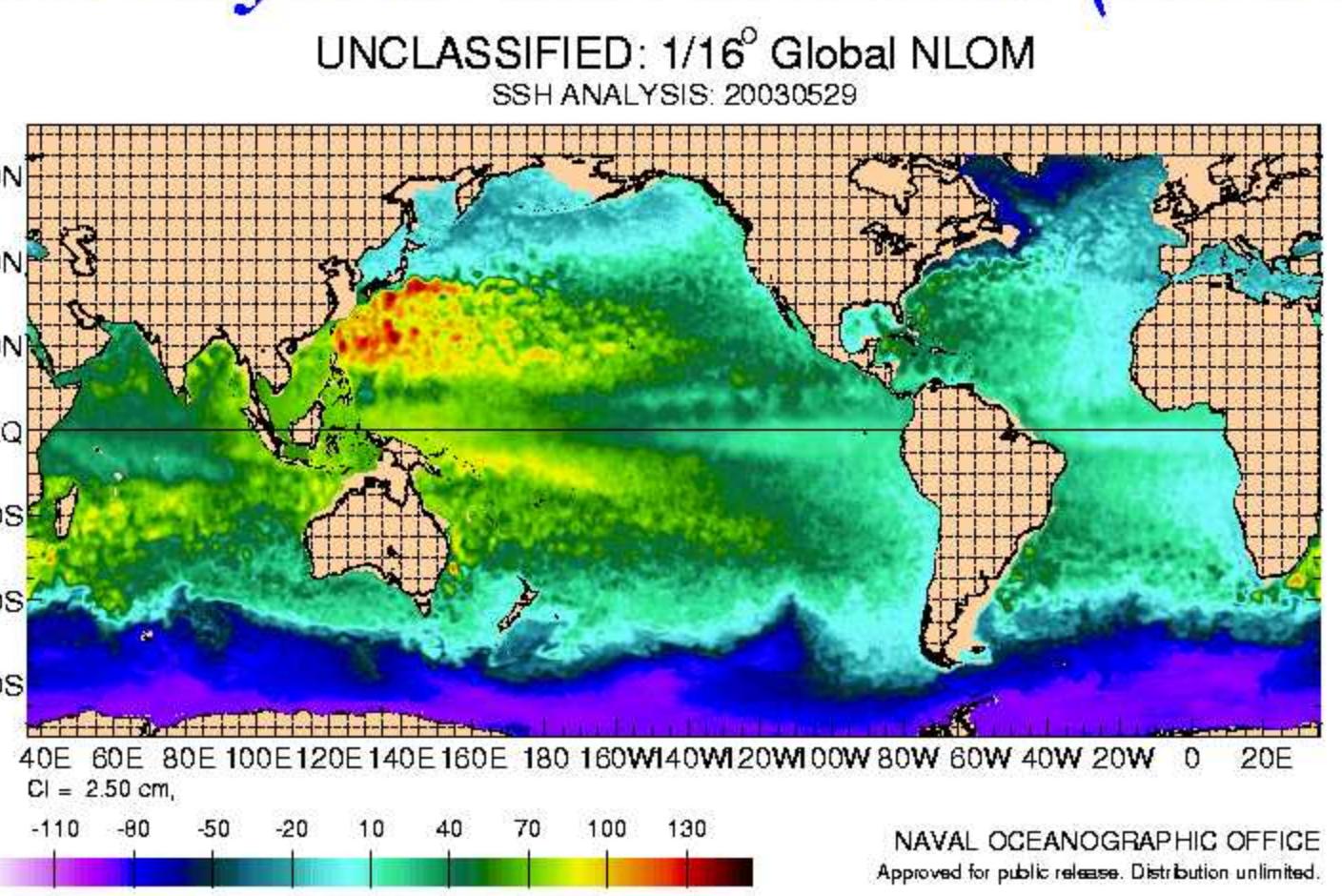
An Operational Real-Time Eddy Resolving 1/16° Global Ocean Nowcast/Forecast System

Real-Time and archived results (updated daily): http://www.ocean.nrlssc.navy.mil/global_nlom

Abstract

An operational real-time eddy-resolving 1/16° global ocean nowcast/forecast system has been running at the Naval Oceanographic Office (NAVOCEANO) since 18 October 2000. The system, which was developed at the Naval Research Laboratory (NRL), uses a NRL Layered Ocean Model (NLOM) with 1/16° resolution and 7 layers in the vertical. Real-time satellite altimeter sea surface height (SSH) from ERS-2, Jason-1 and Geosat-Follow-On provided via NAVOCEANO's Altimeter Data Fusion Center (ADFC), are assimilated into the model. The large size of the model grid (4096x2304x7) and operational requirements makes it necessary to use a computationally efficient ocean model and assimilation scheme. The assimilation consists of an optimum interpolation (OI) deviation analysis of SSH with the model as a first guess, a statistical inference technique for vertical mass field updates, geostrophic balance for the velocity updates outside of the equatorial region and an incremental updating of the model fields to further reduce gravity wave generation. A spatially varying mesoscale covariance function determined from TOPEX/POSEIDON and ERS-2 data is used in the OI analysis. The sea surface temperature (SST) assimilation consists of relaxing the NLOM SST to the Modular Ocean Data Assimilation System (MODAS) SST analysis which is performed daily at NAVOCEANO. Real-time and archived results from the model can be viewed at the NRL web site http://www.ocean.nrlssc.navy.mil/global_nlom. This includes many zoom regions, nowcasts and forecasts of SSH, upper ocean currents and SST, forecast verification statistics, subsurface temperature cross-sections, the amount of altimeter data used for each nowcast from each satellite and nowcast comparisons with unassimilated data. The results show that the model has predictive skill of the mesoscale variability for at least one month.

NRL Layered Ocean Model (NLOM)



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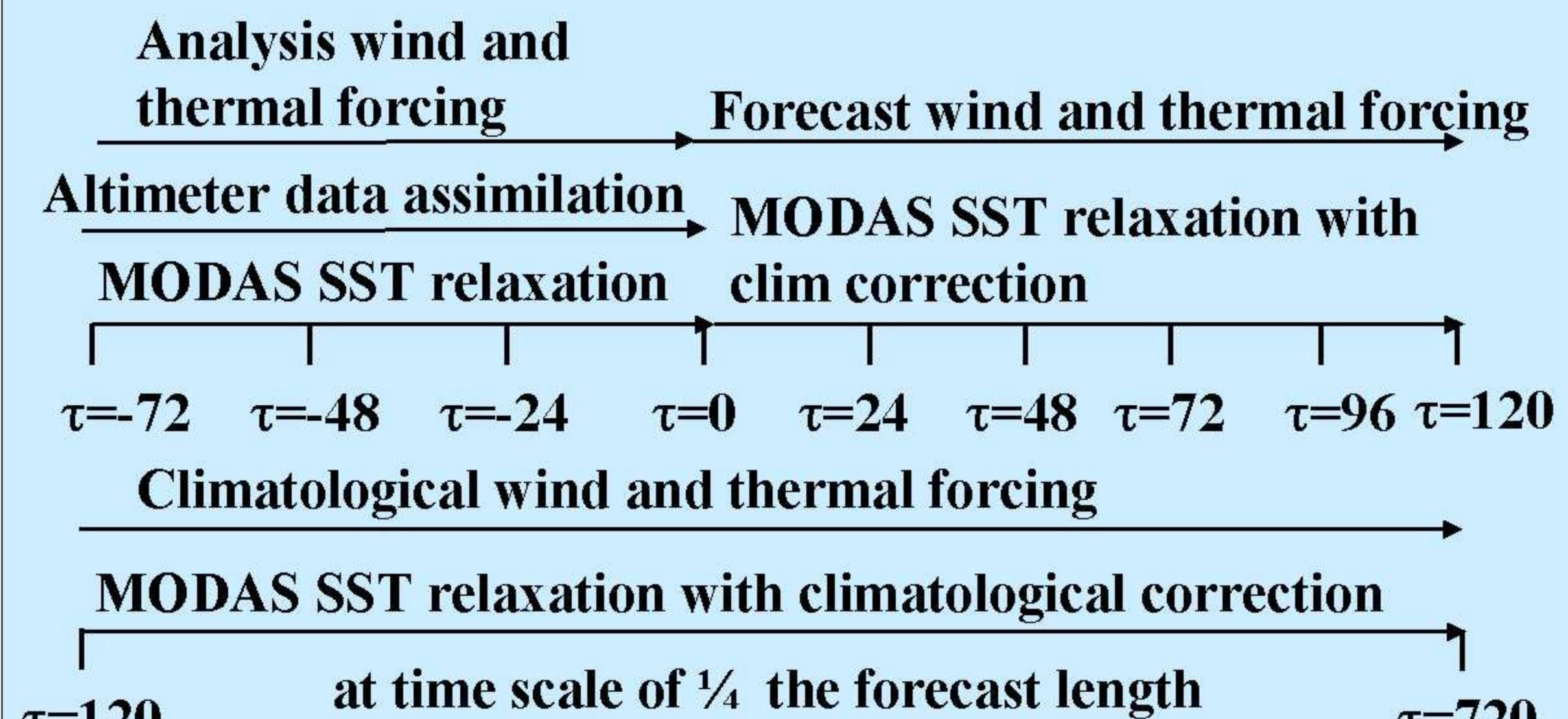
Data Assimilation Methodology

- OI deviation analysis using the model as first guess
 - Mesoscale data covariance from T/P + ERS-2 data calculated by Jacobs et al. (2001, JGR-O)
 - 3-day window for altimeter data
- Subsurface statistical inference via EOF regression
 - Including the abyssal layer which has a major impact on the upper ocean circulation, Hurlburt et al. (1990, JGR-O)
- Velocity changes via geostrophy
 - Outside of equatorial band
- Incremental updating to minimize gravity wave generation
- Assimilation cycles need to go back approximately 3 days to pick up altimeter data with improved orbit removal
 - More recent altimeter data with less accurate orbits are also used
- Relaxation to the daily MODAS SST analysis

Forcing used in operational NLOM

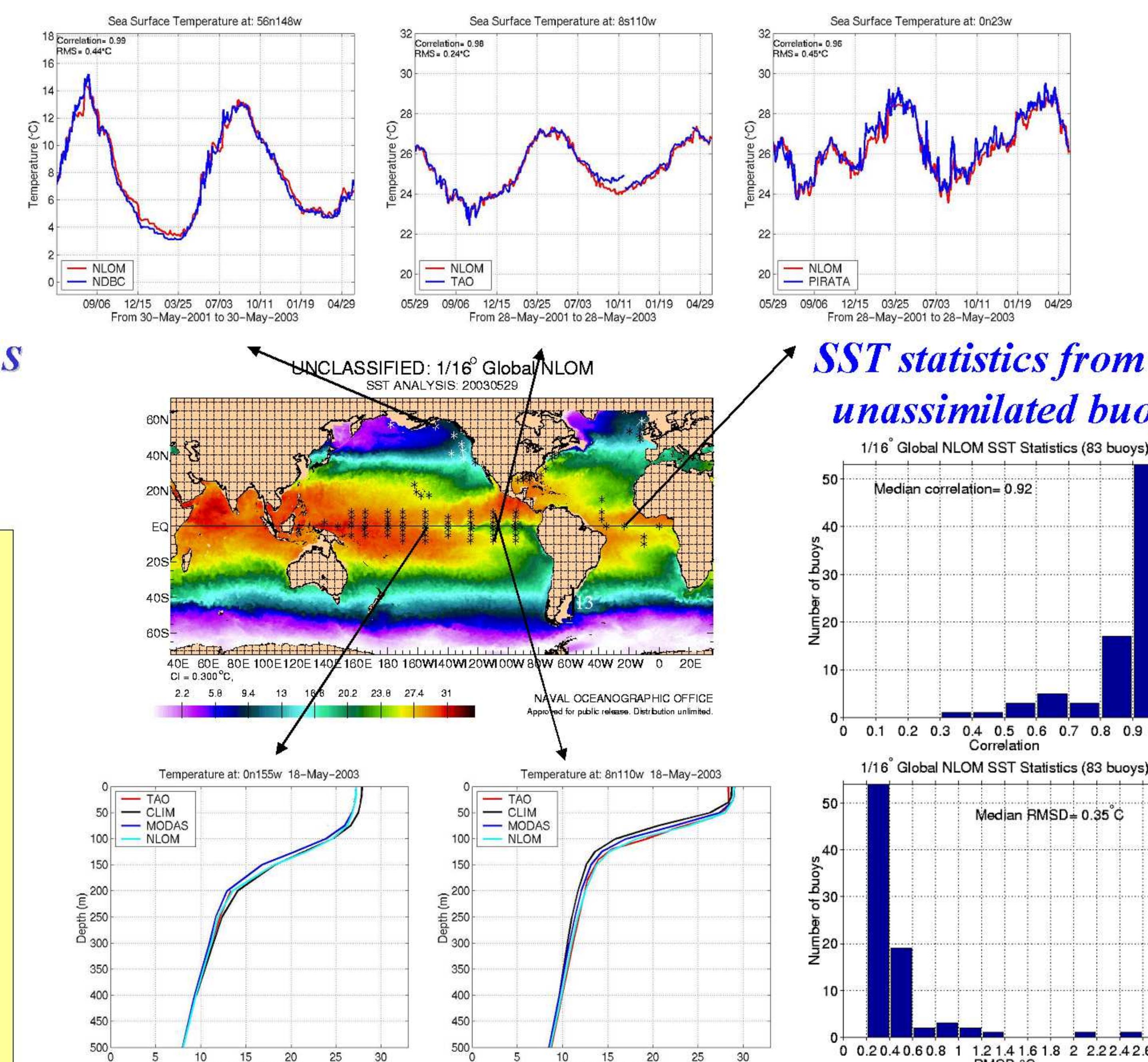
- Winds: 1.0° FNMOG NOGAPS surface stresses
Thermal: 1.0° FNMOG NOGAPS heat fluxes
SST: 1/8° MODAS SST analyses
- In order to utilize the most accurate altimeter data, the system starts three days back in time and uses analysis wind and thermal forcing as it assimilates altimeter and SST data up to the nowcast time
 - NOGAPS forecast wind and thermal forcing are used to produce a 5-day forecast, except on Wednesdays when a 30-day forecast is made
 - Climatological wind and thermal forcing are used to extend the forecasts beyond 5 days
 - In forecast mode, no altimeter assimilation is performed, but SST is relaxed back to the nowcast SST with a climatological correction applied and an e-folding time scale of 1/4 the forecast length

Operational NLOM run cycle



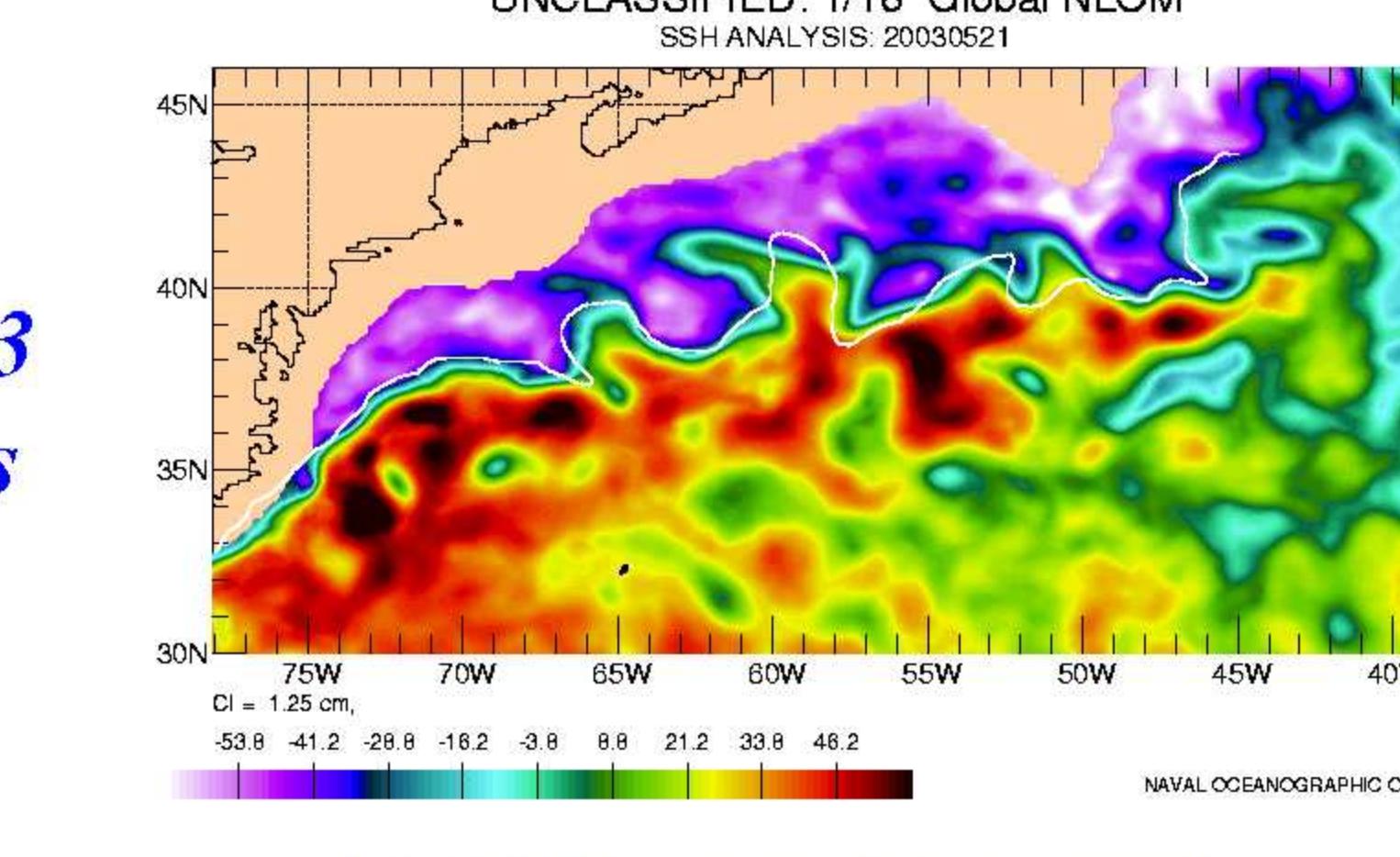
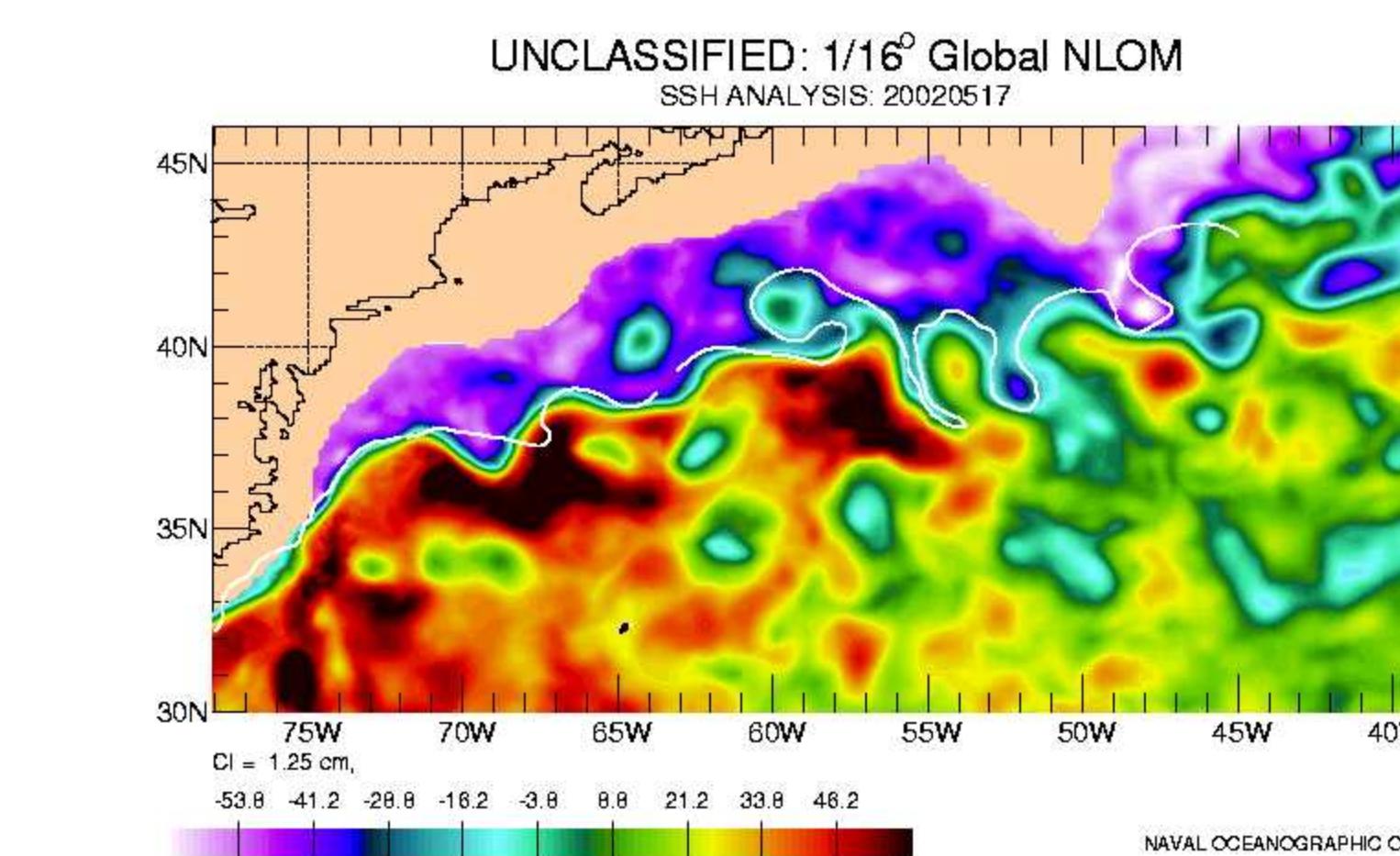
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SST and temperature profile verification

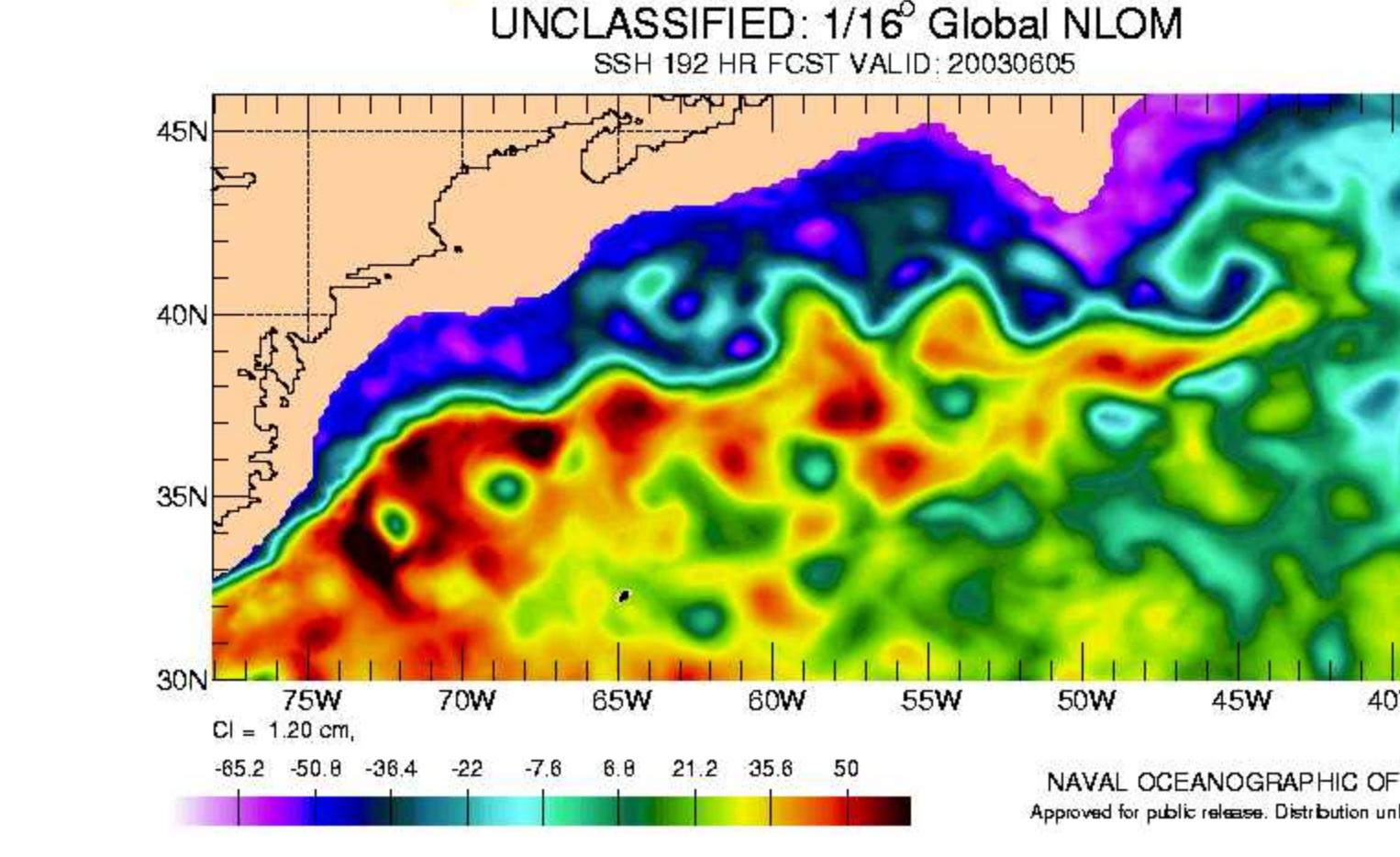


SST statistics from 83 unassimilated buoys

Gulf Stream IR North Wall vs SSH Pathway from NLOM



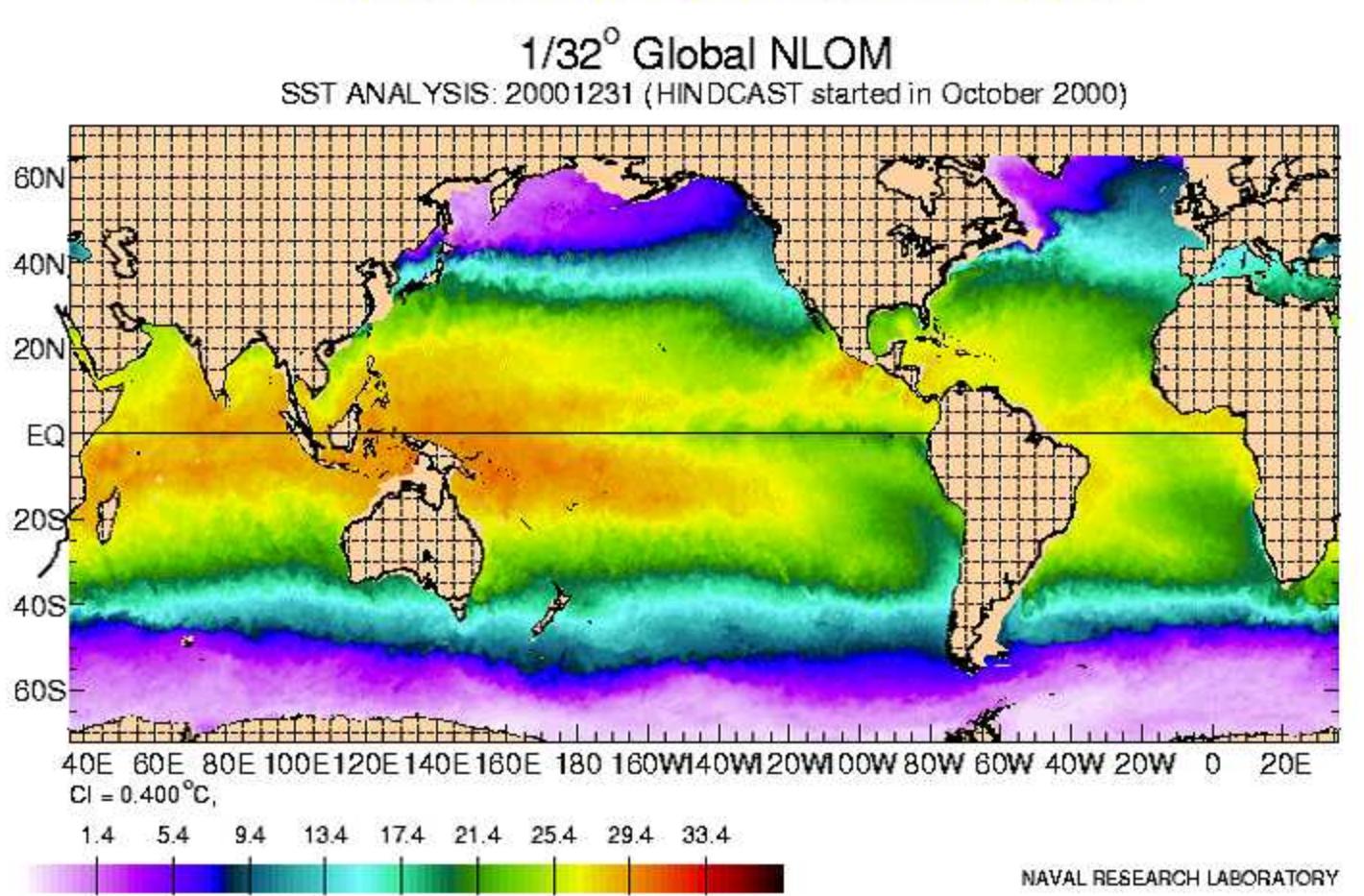
Gulf Stream Forecast



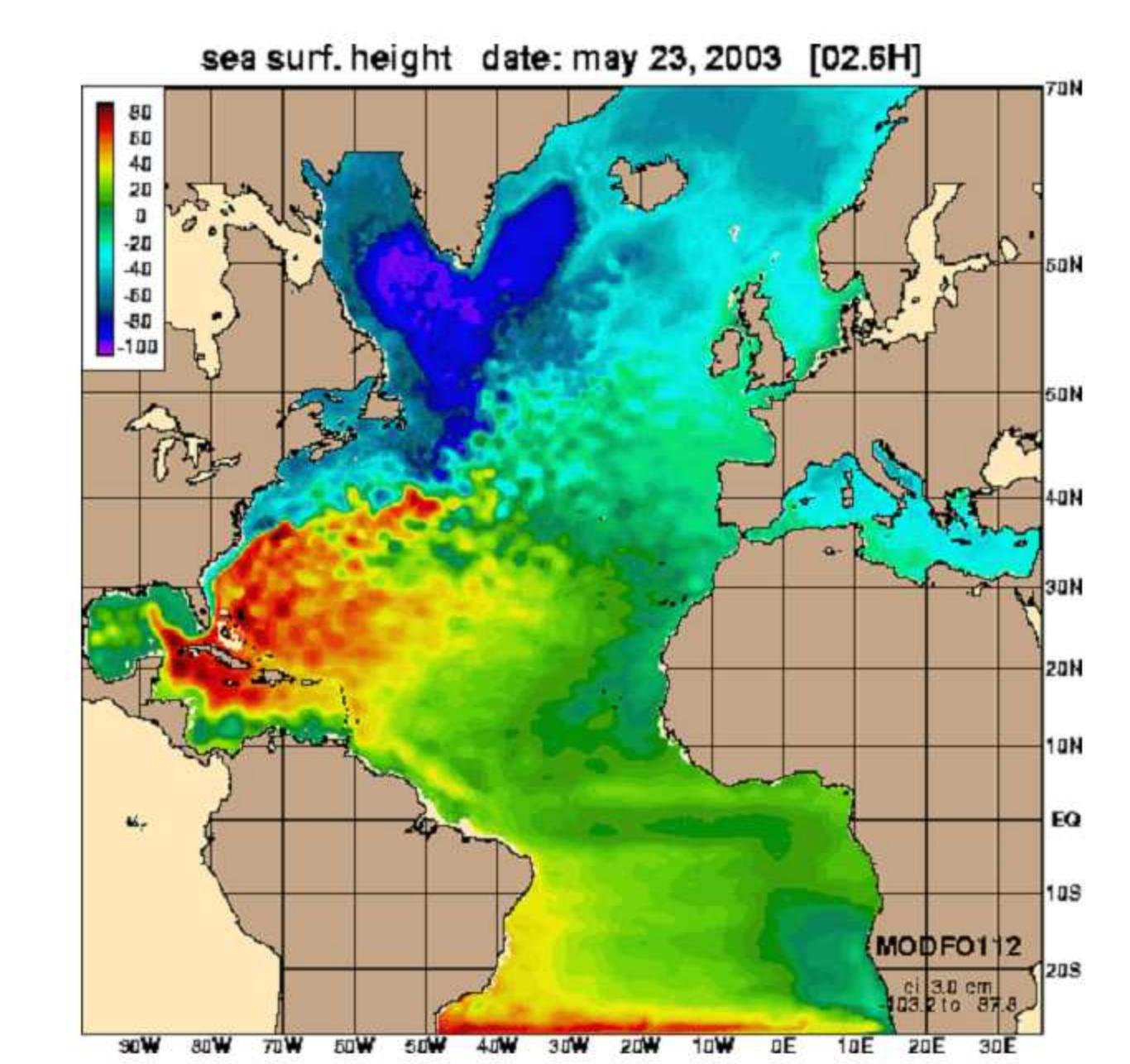
Near real-time and archived results
(updated weekly): <http://hycom.rsmas.miami.edu>

The future

1/32° Global NLOM SST on 31 December 2000



1/12° Atlantic HYCOM SSH on 23 May 2003



HYCOM long term goals for operational prediction

- ? .08° fully global ocean prediction system transitioned to NAVOCEANO in 2006
 - ~7 km mid-latitude resolution
 - Include shallow water, minimum depth 10-20m
 - Bi-polar (PanAm) grid for the Arctic
 - Embedded ice model
- ? Increase to .04° resolution globally and transition to NAVOCEANO by the end of the decade
 - ~3.5 km mid-latitude resolution
 - Good resolution for coastal model boundary conditions globally
 - “Baseline” resolution for shelf regions globally

References:

- Rhodes, R. C., H. E. Hurlburt, A. J. Wallcraft, A. J. Barron, P. J. Martin, E. J. Metzger, J. F. Shriner, D. S. Ko, O. M. Smedstad, S. L. Cross and A. B. Kara, 2002: Navy real-time global modeling systems. *Oceanography*, 15(1), 29-42.
Smedstad, O. M., H. E. Hurlburt, E. J. Metzger, R. C. Rhodes, J. F. Shriner, A. J. Wallcraft and A. B. Kara, 2003: An operational eddy resolving 1/16° global ocean nowcast/forecast system. *Journal of Marine Systems*, 40-41, 341-361.

MODULAR OCEAN DATA ASSIMILATION SYSTEM

